Bounds on Io's Heat Flow

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Temperatures and areas of Io's observed thermal anomalies are analyzed to set an upper bound on Io's total heat flow. We derive an empirical temperature-area distribution function for Io's anomalies. This function permits us to estimate the heat flow from undetected, cooler flows. It also leads directly to the prediction of a limiting, minimum temperature of about 90-95 K for the lava flows corresponding to global coverage. This temperature is in agreement with the minimum temperatures during Io's nighttime measured by the *Voyager* IRIS and the *Galileo* PPR. Furthermore, a logical explanation for these otherwise puzzling nighttime temperature data is provided by the concept that Io's entire surface consists of overlapping lava flows that are at various stages of cooling. Our hypothesis not only explains the relatively high value of the "minimum temperatures" but also their lack of dependence on both latitude and time-of-night. The absence of these dependencies rules out sunlight as a significant source of the power radiated at night. As a result of this, we conclude that Io is covered completely by lava in various stages of cooling (with few possible exceptions, e.g., high mountains). Integration of the thermal emission along our distribution function all the way up to the surface area of Io itself yields the first upper bound for heat flow, 13.5 W m^{-2}, which corresponds to a total global, radiated power of 5.6 x 10^{14} W. This can be compared with ~2.5 W m^{-2} which remains as a lower bound on Io's heat flow. This work was carried out at JPL/Caltech under contract to National Aeronautics and Space Administration.